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Prominent Hill Cu–Au discovery

New diamond field discovered

New zinc discovery in the Flinders

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New diamond field discovered in SA

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Introduction

The Gawler Craton has, for some time, been known to have potential for kimberlite discoveries, Recently, Orogenic Exploration Pty Ltd found a complete range of kimberlitic indicator minerals, and five small diamonds, on Flinders Island, ~40 km offshore from Elliston on western Eyre Peninsula (Fig. 1). While no source kimberlitic bodies have been located to date, the presence of fragile indicator minerals such as diopside, olivine and phlogopite suggests a local source, and confirms the existence of a new diamond field in SA.

This paper discusses the exploration techniques used, and compares the suite of kimberlite indicator minerals from the island with the assemblage of minerals from the known barren kimberlite field near Mt Hope on the adjacent mainland, east of Elliston.

Regional geological setting

Basement outcrop on the island is Hiltaba Suite Calca Granite (~1456 Ma), a holocrystalline coarse-grained, red-brown, strongly feldspathic granite which crops out on the wave-cut platforms and rarely on the interior of the island. Most of the island is veneered by Pleistocene Bridgewater Formation calcrete, which forms spectacular coastal cliffs (Flint, 1992). There are some Holocene coastal sand dunes (Semaphore Sand) and minor lacustrine mud (Yamba Formation) in Gem Pan (Fig. 2).

The island lies just south of the east–west trending Polda Basin which contains Neoproterozoic to Jurassic sediments.

Sixty kilometres east of Flinders Island, on the Eyre Peninsula mainland, Stockdale Prospecting Ltd (now De Beers Australia Exploration Ltd) discovered a number of Jurassic kimberlitic intrusions (Mt Hope 01 to 08) close to Elliston (Mitchell, 1992a,b). Their locations were suggested by the distribution of anomalous kimberlitic indicator mineral collected from surface samples, along with magnetic anomalies defined by detailed aerial magnetic surveys. Their presence was confirmed by drilling. No diamonds were recovered by Stockdale, and this was later confirmed from drilling carried out by Diamond Ventures NL (Cooper, 1998).

Fig. 1 *Location of Flinders Island, and kimberlite occurrences on the mainland.*

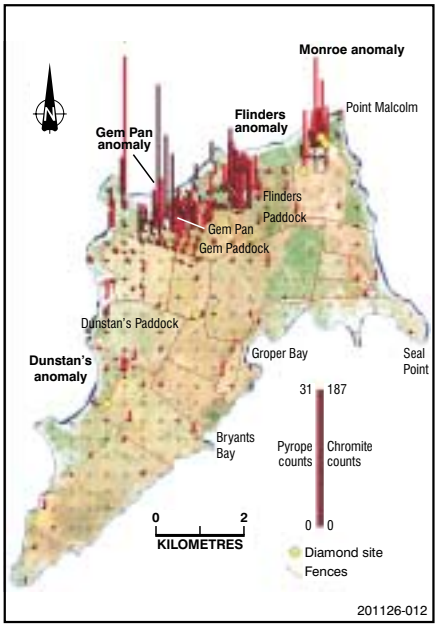


Fig. 2 *Pyrope and chromite diamond indicator counts on Flinders Island at end of December 2001.*

Tenements

Flinders Island (~38 km^2) is owned freehold, with the exception of a thin coastal strip (3.59 km^2) managed by the Department for Environment and Heritage, and a 234 m^2 area around the lighthouse owned by the Federal Government. The island is currently an active sheep station with over 5000 sheep.

Orogenic Exploration Pty Ltd, a small private diamond exploration company based in Melbourne, holds two exploration licences over the island, one

covering the 800 m wide coastal reserve (EL 2875; 24.19 km^2), the other over the remaining central area (EL 2577; 15.55 km^2). Orogenic has in place an option agreement with listed company Tawana Resources NL, which in turn has an agreement with De Beers Australia Exploration Ltd.

Exploration methodology

Traditional heavy mineral kimberlitic indicator mineral sampling has been the main exploration tool used on the island, with 607 surface samples collected to the end of December 2001. Early samples comprised two bags (~30 kg) of surface material screened in the field to -3.2 mm. Most later samples, including the five samples recovering diamonds, comprised one bag (average 15 kg) of -1.6 mm material. As there is no drainage developed on the island, surface sampling has been restricted to soil loam scrapes collecting deflation (wind concentrated) material.

A detailed aerial geophysical survey was flown over the island in June 1999 for Orogenic Exploration Pty Ltd as part of the TEISA area A4 survey. Detailed magnetic, radiometric and digital elevation data were acquired at 50 m line spacing. Extensive areas of the island were recently covered by a 50 m spaced detailed gravity survey to aid in defining drilling targets.

Sampling results

Sampling on Flinders Island has shown that the dispersion of indicator grains is very restricted, and that more traditional wide-spaced sampling programs would probably overlook similar indicator mineral anomalies. It confirms the need for systematic sampling using closer spacing within this environment.

A wide range of indicator minerals has been recovered from the island, including the traditional chromite, pyrope, diopside, and picroilmenite minerals, as well as forsterite, orthopyroxene, phlogopite and diamond. Four distinct indicator anomalies have been defined to date — Gem Pan, Flinders, Monroe and Dunstan's. The highest grain counts are centred around Gem Pan, on the northwestern side of the island, covering most of the western half of Gem Paddock (Fig. 2).

Covering the northwestern corner of Flinders Paddock, centred along the northern coast, is the Flinders anomaly. Like the Gem Paddock area, chromite dominates the grain counts. There are low but significant grain counts in the area between the Gem Pan and Flinders anomaly areas; these two areas may therefore be related.

Further east, near Point Malcolm, is the Monroe anomaly from which three of the five diamonds were recovered. This grain anomaly, which contains more equal counts of chromite to pyrope, is very discrete.

Located halfway down the island, near the west coast, is Dunstan's anomaly. Counts here are low, but all the indicator minerals (excluding diamond) have been recovered.

Further isolated recoveries of various indicator grains have been made across the island; some of these will require further sampling to define their significance.

The chemistry of indicator grains recovered from the island is indicative of the presence of diamonds, which has been confirmed by the recovery of five diamonds from surface samples. Representative microprobe analyses are provided in Table 1 for two samples collected near Gem Pan.

Chromite

Chromite is the dominant kimberlitic mineral on Flinders Island; over 2500 grains have been recovered, and the chemical properties confirmed by over 2300 microprobe analyses. A significant number of grains fall into the diamond inclusion field based on MgO, TiO_2 and Cr_2O_3 contents.

Ninety-four percent of the microprobed chromite grains have Fe^{+++}/Fe^{++} ratios which indicate a kimberlite oxidation state favourable for diamond preservation. This is in line with the picroilmenite data.

Chromite grains from sample FX-241. Grains are 0.3 mm across. (Photo 48401)

***Table 1**. Representative analyses of some grains recovered in two samples near Gem Pan — chromite (CHR), clinopyroxene (CPX), garnet (GNT), ilmenite (ILM) and olivine (OL).*

SAMPLE (FIS)	12	12	12	12	12	14	14	14	14	14	14	14
Mineral	CHR	CHR	CHR	CPX	GNT	CHR	CHR	CHR	CPX	GNT	ILM	OL
SiO_2	0.17	0.29	0.10	51.73	40.53	0.14	0.18	0.12	51.83	39.88	0.02	40.50
TiO_2	0.15	0.76	1.72	0.25	0.10	0.11	0.22	0.08	0.22	0.08	49.21	0.01
Al_2O_3	17.34	7.90	7.78	2.75	15.40	16.82	5.84	6.94	2.74	13.58	0.64	0.02
FeO	13.38	16.48	20.11	4.05	3.91	13.58	16.99	14.82	1.70	3.60	19.30	9.16
MnO	0.06	0.53	0.16	0.15	0.34	0.10	0.11	0.14	0.12	0.37	0.15	0.12
MgO	14.21	9.29	9.17	14.87	21.33	13.68	10.69	10.16	16.75	18.56	13.74	50.15
CaO	0.00	0.20	0.02	22.98	4.86	0.01	0.00	0.00	22.98	8.28	0.00	0.07
Cr_2O_3	52.31	62.15	60.09	0.24	11.13	52.52	60.62	67.45	0.51	13.41	11.04	0.01
V_2O_5	0.13	0.24	0.21	0.01	0.00	0.11	0.19	0.18	0.05	0.08	0.42	0.01
NiO	0.11	0.19	0.08	0.06	0.00	0.16	0.12	0.11	0.06	0.03	0.33	0.39
Fe_2O_3	2.67	0.00	0.00	2.36	2.94	2.23	5.67	0.00	2.87	3.33	5.92	-
Na_2O	0.00	0.04	0.03	0.39	0.02	0.00	0.01	0.02	0.21	0.02	0.02	0.00
Total	**100.53**	**98.07**	**99.47**	**99.84**	**100.56**	**99.46**	**100.64**	**100.02**	**100.04**	**101.22**	**100.79**	**100.44**

Pyrope

Pyrope is the next dominant indicator mineral, with over 260 grains recovered. These include mostly G9 lherzolitic (mainly olivine–pyroxene rock) pyrope, seven classical G10 harzburgitic (mainly olivine–orthopyroxene rock) grains, and minor low-chromium lherzolitic garnet. This would indicate a lower proportion of depleted harzburgite–dunite in the mantle xenolith suite sampled by the unknown kimberlite compared to lherzolite.

The range of Cr_2O_3 in the peridotitic garnet is encouraging, with a well-defined population between 6 and 15 wt% Cr_2O_3. The seven G10 pyrope grains have significant Cr_2O_3 (all over 8 wt%) which plot within the more restrictive G10 diamond field.

The only known distribution of other G10 pyrope grains in SA is from the northern Springfield Basin (five grains around 6% Cr_2O_3), and one grain from the Sugarloaf Dam kimberlite sill, 20 km west-northwest of Port Augusta.

Picroilmenite

Over 120 picroilmenite (ilmenite with MgO >4%) grains have been micro-probed from Flinders Island. The Cr_2O_3 wt% contents of kimberlitic picro-ilmenite generally range up to 7%. Significantly, 27 picroilmenite grains recovered from the island plot with >7% Cr_2O_3. The highest is a grain from sample FIS 24 near Gem Pan, with 22.8% Cr_2O_3. Similar individual high chromium picroilmenites are known from inclusions in the diamonds from Mwadui Kimberlite, Tanzania, with a reported 16.2% Cr_2O_3 (Stachel et al., 1998), and from the Venetia Kimberlite, South Africa, with 12.03% Cr_2O_3 (Viljoen et al., 1999). Viljoen et al. believed that the very high chromium picroilmenites are from metasomatised peridotite xenoliths.

Preservation index for diamonds is high to very high based on the Fe_2O_3, FeO and MgO contents of the recovered picroilmenite grains. Thus, the oxidation condition in the kimberlite would not have resulted in significant resorption of any diamonds present.

Diopside

Over 150 fresh diopside grains have been recovered from the island. Diopside is a mineral that does not survive and travel well in the Australian environment.

Olivine

Olivine is rarely used as a kimberlitic indicator mineral as it occurs in abundance in basalt and other ultramafic rocks, but kimberlitic olivine does have certain chemical characteristics that can eliminate many other olivine-bearing source rocks. Olivine also does not survive long near the surface and its presence usually indicates proximity to source.

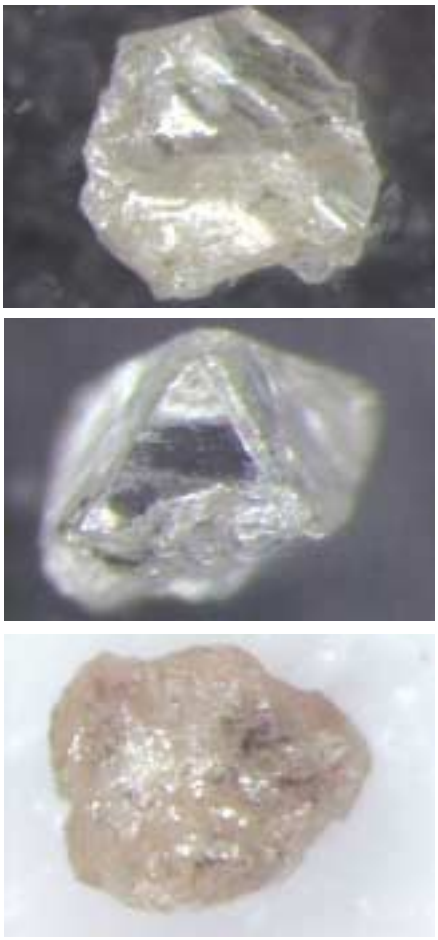
Over 60 olivine grains from Flinders Island have been microprobed, and most are close to the forsteritic end member and contain significant traces of NiO (average 0.32 wt%). While not completely diagnostic of kimberlite, the results are very encouraging as the only known regional bedrock lithology is granite.

Diamond

Three small diamonds were recovered from the June 2000 regional 400 m grid sampling program from three individual, widely spaced samples. Follow-up sampling recovered a microdiamond in each of two separate samples located near one of the original diamond sample sites within the Monroe anomaly area. It is worth noting that a different laboratory was used for the follow-up sample processing, thus eliminating the possibility that the first three diamonds were sourced from contamination.

Diopside grain (0.3 mm across) from sample FX-212. (Photo 48402)

Olivine grain (0.3 mm across) from sample FX-210. Note the well preserved crystal edges. (Photo 48403)



***(Top to bottom)** Diamonds from sample sites FX-003 (centre of island), FX-070 (Monroe anomaly), and FX-149 (south of Dunstan's Anomaly). These three stones were in the 0.3–0.5 mm size fraction.* (Photos 48404, 48405 and 48406)

The diamonds are small, but only the 0.3 to 1.0 mm fraction from the loam samples was examined for indicator minerals. No examination of coarser fractions is possible as the samples contain very little material above 1 mm. No samples have so far been collected specifically for microdiamonds from Flinders Island.

Comparison with kimberlite from Mt Hope

The chemistry of the indicator minerals from Flinders Island is very different to that of indicator minerals recovered from the mainland kimberlite occurrences near Mt Hope. Since both fields are located in close proximity on the Gawler Craton, it is important to observe the differences between the two mineral

assemblages. Direct contrasts can be seen between the chromite, picroilmenite and clinopyroxene compositions shown on Figs 3–5. Further differences include the lack of diamond-inclusion-field chromites (see Sobolev, 1971) recovered from the mainland kimberlite occurrences. Chromite grains

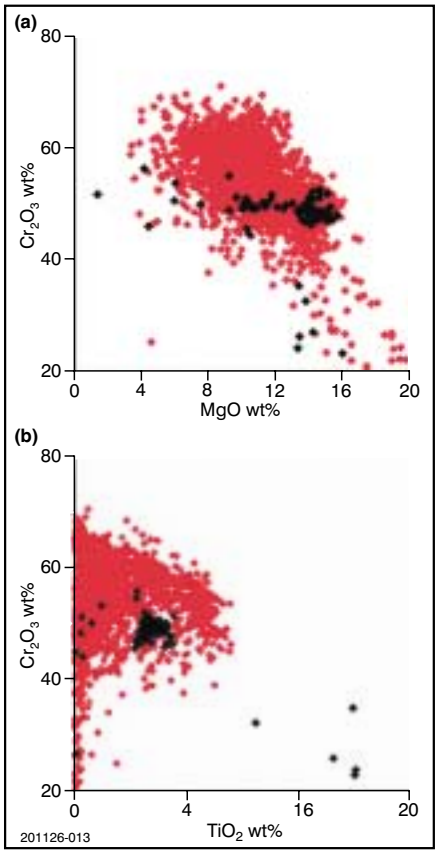


Fig. 3 (a) *Plot of wt% Cr_2O_3 versus MgO, and* ***(b)*** *Cr_2O_3 versus TiO_2, for chromite grains from Flinders Island (red) and Mt Hope (black). Mt Hope data is from Cooper (1998).*

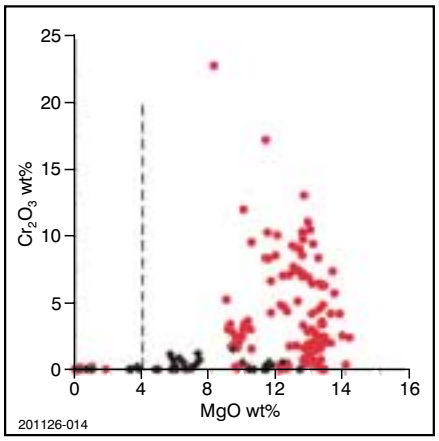


Fig. 4 *Plot of wt% Cr_2O_3 versus MgO for ilmenite from Flinders Island (red) and Mt Hope (black). Mt Hope data is from Cooper (1998).*

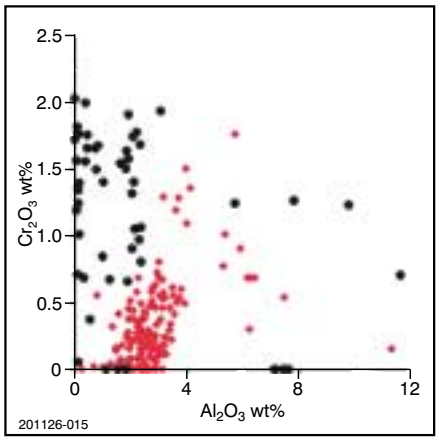


Fig. 5 *Plot of wt% Cr_2O_3 versus Al_2O_3 for clinopyroxene from Flinders Island (red) and Mt Hope (black). Mt Hope data is from Cooper (1998).*

plotted on Figure 3 show that the Flinders Island chromite forms a very different population based on higher Cr, and spreads of Mg and Ti contents compared to that from Mt Hope.

Picroilmenites from the Mt Hope area differ from those on Flinders Island in that the latter have higher than average MgO contents and substantially higher Cr_2O_3 contents. Clear differences are also observed between the diopside samples recovered from both areas, based on Al_2O_3 and Cr_2O_3 content.

No fresh olivine was recovered from kimberlite in the Mt Hope area.

Conclusions

Diamond indicator mineral grains have been recovered from sites with very poor sample conditions on Flinders Island. The range of minerals and the number of grains recovered have been outstanding. This, combined with favourable grain chemistry and the discovery of diamonds, make the project very exciting. It is now a matter of locating the origin of the indicator grains and diamonds, which is presumed to be a kimberlitic source and probably not too far distant, given the presence of fragile minerals such as diopside, olivine and phlogopite.

This discovery now upgrades the overall potential of the Gawler Craton for diamonds. The stark differences between the Mt Hope and Flinders Island indicator grain chemistries illustrate that rapid lateral changes in diamond potential does occur.

Acknowledgements

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For further information contact Steven Cooper (mob. 0428 100 995).

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